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ITALY'S INSTITUTE OF RESEARCH ON ELECTROMAGNETIC
WAVES--THE ISTITUTO DI R. (U) OFFICE OF NAVAL RESEARCH
LONDON (ENGLAND) D J COLLINS 18 AUG 87 ONRL-7-821-R

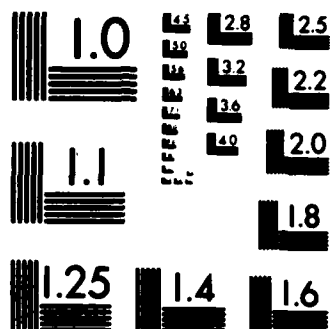
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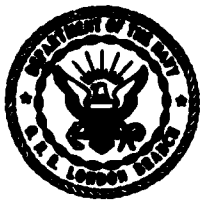
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Italy's Institute of Research on Electromag-
netic Waves--The Institute Di Ricera Sulle Onde
Elettromagnetiche

Dr. Daniel J. Collins

10 August 1987

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U.S. Office of Naval Research, London

87 9 10 203

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b RESTRICTIVE MARKINGS		
2a SECURITY CLASSIFICATION AUTHORITY			3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited		
2b DECLASSIFICATION/DOWNGRADING SCHEDULE					
4 PERFORMING ORGANIZATION REPORT NUMBER(S) 7-021-R			5 MONITORING ORGANIZATION REPORT NUMBER(S)		
6a NAME OF PERFORMING ORGANIZATION US Office of Naval Research Branch Office, London		6b OFFICE SYMBOL (If applicable) ONRL	7a NAME OF MONITORING ORGANIZATION		
6c ADDRESS (City, State, and ZIP Code) Box 39 FPO, NY 09510			7b ADDRESS (City, State, and ZIP Code)		
8a NAME OF FUNDING/SPONSORING ORGANIZATION		8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c ADDRESS (City, State, and ZIP Code)			10 SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO	PROJECT NO	TASK NO
					WORK UNIT ACCESSION NO
11 TITLE (Include Security Classification) Italy's Institute of Research on Electromagnetic Waves--The Istitute Di Ricera Sulle Onde Elettromagnetiche					
12 PERSONAL AUTHOR(S) Dr. Daniel J. Collins					
13a TYPE OF REPORT Technical		13b TIME COVERED FROM _____ TO _____		14 DATE OF REPORT (Year, Month, Day) 10 August 1987	
15 PAGE COUNT 4					
16 SUPPLEMENTARY NOTATION					
17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
20	06		Optics		
09	02		Lidar		
			Digital Signal Processing		
19 ABSTRACT (Continue on reverse if necessary and identify by block number)					
<p>The activity of this laboratory are reviewed. Of particular interest is the work in micro-optics and optical sensors, integrated optics, remote sensing, and signal processing.</p> <p><i>Keywords included:</i></p>					
20 DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS			21 ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a NAME OF RESPONSIBLE INDIVIDUAL C.J. Fox			22b TELEPHONE (Include Area Code) (44-1) 409-4340		22c OFFICE SYMBOL 310

1 INTRODUCTION

2 MICRO-OPTICS AND OPTICAL SENSORS

can be produced by a small, local medical instrumentation company. Indeed, the testing program of the temperature probe at IROE was being conducted with participation of personnel from that local company--a good example of one of the means used in transferring technology to local industry. I was told that the device was accurate to 0.1 degree. Three other optical sensors or devices, all of which involved optical fibers, were being developed in the laboratory. One was concerned with the measurement of pH based upon the change in optical behavior of a dye solution, and another, using a very small beam splitter, was being used to detect position by means of interference patterns. The high-efficiency beam splitter, of the size of the optical fibers, was a device developed in the US. (The engineer working with this setup had, in fact, just spent a year working in the US.) The last optical device I saw was concerned with measurement of temperature by the absorption spectra of high-temperature gases.

3 INTEGRATED OPTICS

The work in the integrated optics group (about four people) has practical applications in the development of integrated optical processors and in multiplexing-demultiplexing devices for optical communication. I talked to Dr. S. Sottini, who mentioned some of his early work in holography. Sottini has also worked with optical planar waveguides and has a patent in this area. He recently spent a year at the University of California at Irvine where he worked on a problem involving acoustical-optical interactions on a sphere. In his current work, which is part of a special CNR project, Sottini has been concerned with the analysis of the aberrations in a geodesic lens (Righini et al., 1986). The actual lens is one of the simplest geodesic lenses--that of a hemispherical wave guide. Although the perfect geodesic lens must involve aspheric surfaces, the hemispherical lenses have interesting properties, which include the ability to form, very compact and rugged multilens



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systems. The laboratory has under test a multiplexing device for optical fibers which uses a quarter sphere. They also have a simple, inexpensive method using radiant heating for automatically manufacturing the wave guides at the end of an optical fiber. In one of the newer projects Dr. G. Righini is working on the interaction of a magnetostatic wave with light in garnet, which has applications in multiplexing and demultiplexing light signals.

4 REMOTE SENSING

The remote sensing group, headed by Professor L. Pantani, is a fairly large group of 25 people engaged in research. For me, the most fascinating project at IROE-CNR was the light detecting and ranging (LIDAR) device designed and developed at IROE by Giovanna Cecchi. The device, called FLIDAR-2, resulted from the work at IROE-CNR on the remote sensing of the environment by (LIDAR) fluorosensors and passive optical sensors. FLIDAR-2 is based on a new idea in remote sensing of the environment involving a (LIDAR) fluorosensor and a passive spectrometer which permits the attaining of real-time high spectral resolution data of laser-stimulated emissions (LIDAR function) and of target reflectance (spectrometer function). (Castagnoli, et al., 1987). The sensor unit consists of an excimer laser (built at IROE) with a wavelength of 308 nm which excites a dye laser or Raman shifter. The excitation wavelength can be shifted from the ultraviolet to the near-infrared. The detector is a 512-element, intensified, gated diode array. I witnessed a demonstration of the FLIDAR-2 device detecting a sheet of paper over a 10-meter range. Spectra was displayed automatically on the controlling minicomputer. The design range of the device is 100 meters but it can probably be used to 300 meters. According to Cecchi, there are about five FLIDAR-2 devices in existence in the world (three in US) but she feels that the IROE device with 512 channels has the best resolution. FLIDAR-2 has been designed to fly in an airplane, and this

facilitates such applications as sensing thermal pollution and oil on the surface of water. IROE has developed several collaborative efforts with a wide range of institutions in order to further the practical applications of the device. These include the Deutsche Forschungs und Versuchsanstalt für Luft und Raumfahrt (DFVLR) at Munich and the University of Hallenburg in Austria and institutes in Belgrade, Yugoslavia, and in the Netherlands. The applications include agriculture/forestry monitoring involving erosion, crops, and timberland (acid rain), and atmospheric monitoring of cloud cover and the ozone layer. Future improvements in the device will include a time-resolved channel for bathymetry and vegetation thickness measurements and a scanning mirror for image LIDAR and image spectrometry.

The group has been previously involved with the defense mapping agency in satellite observation, mainly in the development of software. Studies of the ionosphere composition have been conducted since 1962. Measurements have been made in the ionosphere using the first Italian satellite, SIRIO, to obtain the total electron content, but the loss of the second Italian satellite on launch has hampered this work. Some thought is being given to the use of the GPS system. There is some further effort concerned in the area of meteorology and with satellites.

5 SIGNAL PROCESSING

One of the areas in which IROE has had considerable experience is that of signal processing. In their satellite work the laboratory has been involved in data compression techniques, efficient transmission of data, and error-correcting codes. The laboratory's work in biotelemetry and medical instrumentation led to work in two-dimensional data processing involving scanners and photograph interpretations. Dr. F. Lotti, who was my host for the visit, is in charge of the group concerned with digital signal processing.

The current work of Lotti's group is on an EEC ESPRIT project which aims to

develop an automated scheme for real-time nondestructive testing of composites (Lotti et al., 1984). ESPRIT projects (see ESN 40-11:411-414 [1986] for most recent update) are multinational and also involve normally an industrial concern. The partners in this project in addition to IROE are the University of Strathclyde, Glasgow, UK, and Barr and Stroud Limited, Glasgow.

IROE is analyzing data from a technique recently developed at the Non-destructive Testing Center at Harwell, UK. In this technique, which is called video-compatible transient thermography, a transient thermal field is created in the composite material which creates temperature variations on the visible surface. These temperature variations are recorded by high-resolution infrared scanners on video tape, yielding the temperature profile of a given area as a function of time (Lotti et al., 1984). In order to use this technique for automatic inspection of composite materials one needs the temperature profile of specimens with and without defects. These temperature profiles create a data base which can be used to decide the condition of a given test specimen. The creation of this data base by the digitizing of the analog video images has been the task of IROE-CNR. This has involved the application of sophisticated image processing algorithms. The original video tapes were prepared by Barr and Stroud in Glasgow and the analysis or strategy applied in the use of the data base to determine the defects from the temperature fields will be the concern of Professor T. S. Durrani of Strathclyde. The detection of inhomogeneities is based on the spatial variation of temperature which may be contaminated by noise and a nonuniform background. The characterization of the flaws will be based on the time variation of the profiles. I had an opportunity to review some of the digitized images and was impressed by their clarity and the ease with which they could be manipulated. ESPRIT projects last for 3 years, and this project's second year is now being completed. The final year will be concerned with developing the design

criteria of a very large scale integration (VLSI) implementation of special-purpose hardware. My understanding is that a prototype device will be built as part of the project.

6 FUNDAMENTAL RESEARCH

In a series of what could be termed fundamental investigations, Dr. M. Bacci of IROE has been interpreting the spectroscopic and structural properties of molecules in light of the Jahn-Teller effect. Bacci has analyzed this effect in vibronic coupling of biomolecules, in the analysis of the optical properties of thalliumlike impurities in alkali-halide crystals, and in his recent paper on five-coordinate copper(II) complexes (M. Bacci, 1986). Another recent paper is concerned with systems exhibiting spin equilibrium. I mention Bacci's work because of the very fundamental nature of the investigations. Bacci's work indicates that although emphasis in the IROE-CNR is on technology transfer and perhaps on applied results, there is still support of more fundamental research.

7 CONCLUSION

I was particularly impressed by IROE's LIDAR device for remote sensing. It should prove to be very productive in the area of remote sensing. In the applied optics area the laboratory has a large effort in the development of optical devices. I also thought that the digital signal processing work was state of the art. My impression was that IROE-CNR serves a function similar to the small research companies that cluster about university complexes in the US. The combination of such laboratories and universities can create a strong technical base.

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